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WAGE REDISTRIBUTION AND THE LONG RUN PHILLIPS CURVE

by

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ABSTRACT

We derive a long-run Phillips curve that is negatively sloped at low inflation rates. Due to exogenous changes, unions want to redistribute wages across different members also in the long run. Wage stickiness, inflation targeting and union solidarity are central characteristics of our New Keynesian model. In the model, high enough inflation becomes the grease of the economy that allows wage redistribution across unions without causing unemployment to rise above NAIRU. We show that under nominal wage rigidity, long-run unemployment may rise drastically and at zero inflation, unemployment may be trapped at very high levels even if demands for wage redistribution tapers off. Under real wage rigidity, the economy may get trapped at high unemployment also at *positive* but low inflation rates irrespective of demand for wage redistribution has vanished or not. Thus, a period of wage redistribution may cause an economy of full real wage rigidity to get trapped at a high unemployment rate. A policy conclusion is that economies characterized by extensive wage rigidity should not target inflation at too low levels.

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Introduction

One of the most influential contributions in economics is that the long-run Phillips curve (LRPC) is vertical i.e. that unemployment settles at the fixed natural rate at any inflation level.[1] An expression for the influence of this view is that Central banks target inflation at historically low levels like two percent. One reason for the forceful influence of the hypothesis of the vertical LRPC is the simplicity of the NAIRU model. The model can be understood not only by professional economists but also by policy makers. Many researchers' intellectual investments in the model and the fact that inflation targeting rests on credibility of the target makes it unlikely that low level inflation targeting will be abandoned.

Nevertheless, several studies have questioned the basis of low inflation targeting, i.e. the notion of the vertical LRPC. If the LRPC instead implies an inflation-unemployment trade-off at low inflation, the implication is that low inflation targeting may give rise to unemployment above the NAIRU level. Akerlof, Dickens and Perry (2000) presented a model in which firms' wage and price setting is different at low inflation than at high in the sense that inflation tends to be disregarded at low levels. With these assumptions, the LRPC becomes negative at low enough inflation and an inflation rate exists that minimizes unemployment. When tested empirically, they concluded that US inflation should be somewhere between 1.5 and 4.0 percent to minimize unemployment. When basically the same model was applied to a small open economy like the Swedish, Lundborg and Sacklén (2006) found similarly strong support for the model. Their preferred regressions imply that inflation should be somewhere between 3.5 and 4.0 percent, way above the present two percent inflation target, to minimize unemployment in Sweden. Since the vertical LRPC is nested in the Akerlof et al model, the empirical results for both the US and Sweden reject the notion that the LRPC is vertical at low inflation.

Holden (2004) constructs a bargaining model based on legal requirements in many European countries that nominal wage contracts can only be changed by mutual consent, giving workers a stronger bargaining position at low inflation. The key implication of this model is also a long run trade-off between unemployment and inflation at low inflation rates.

[1] Friedman (1968), Phelps (1970).

Researchers have also proposed that downward nominal wage rigidity (DNWR), a prominent feature of developed economies, may be a credible source of a negatively sloped LRPC. The focus on DNWR goes back to Keynes (1936) and has been a recurrent theme ever since.[2] In Keynes' version, individual workers or groups of workers care about relative rather than absolute real wages. They may withdraw labor from the market if their wages fall relative to others but would not necessarily do so if all real wages fall uniformly. Unless the wage bargaining process is fully controlled by the government or by economy-wide bargaining by the social partners so that all wages are reduced uniformly in a slump, inflation is needed to do the job of adjusting relative wages.

It has been established that employers as well as employees are reluctant to accept nominal wage cuts.[3] In a model with optimizing firms and explicit DNWR under all but extreme circumstances, Akerlof, Dickens and Perry (1996) show that the effects of DNWR are large in terms of lost employment during low inflation. Firms that perform poorly and make losses during a slump with low inflation cannot lower real wages and firms then need to cut down on employment. Only when losses are sustained over several years in a row will it be possible to lower real wages.

In this paper we explore further the consequences of wage rigidity. However, we make a quite different analysis than Akerlof et al (1996) of the mechanisms that cause wage rigidity to generate a negative LRPC. One reason for introducing credible low inflation targeting in highly unionized economies is the expected disciplinary effect on unions' wage setting. In particular, if some unions demand an extra wage increase for their members, other unions need to restrain their wage demands correspondingly so that overall wage increases are in line with the inflation target. This setup requires an active union policy for wage solidarity. However, there are limits to solidarity. Downward nominal wage rigidity and downward real wage rigidity (DRWR) represent such limits and we show how demands for wage redistribution under DNWR and DRWR matter for the slope of the LRPC.

The driving force behind the negative slope of the long-run Phillips curve is thus the demands for wage redistribution. Much of the discussions on changes in relative wages across unions take place publicly and a public support for an extra wage increase for some union(s) may

[2] See e.g. Tobin (1972), Akerlof, Dickens and Perry (1996).
[3] See Agell and Lundborg (1995) (2003), Bewley (1999), Campbell and Kamlani (1997), Akerlof et.al. (1996).

facilitate the achievement of the wage objectives. Our analysis rests on the observations that often before or during wage negotiations there are discussions about the needs for extra wage hikes for some groups of workers above the wage increases of other groups. This demand from trade unions to redistribute wage income across members of different unions may be due to exogenous changes in preferences, technology, work environment etc. The redistribution of wages is often the result of social needs and is not necessarily the results of union policy *per se*. While support often can be obtained for a redistribution of wages that is in line with social objectives, wage rigidity, which becomes a problem particularly in low inflation periods, may prevent the necessary wage adjustments and cause unemployment to rise.

Some examples of the type of wage redistribution across unions that we want to capture in the model are the following. The most frequent redistribution may be that egalitarian oriented trade unions tend to demand relatively higher wage increases (in percent) for unions organizing the lowest paid members. This was particularly common in the 1960.s and 1970.s among egalitarian oriented unions in the OECD area and particularly so in Sweden. To the extent that disciplinary effects are present, this requires some restraint from the unions representing better paid members. The long run effects of these wage redistributions showed up in terms of a highly egalitarian wage structure.

Another example from Sweden concerns teachers' wages. After a public discussion about the need to improve schooling results, teacher unions requested a wage premium above the increase of other unions so as to raise the quality of teachers. Since the quality of teachers is in the general interest, other unions largely supported the request. Facing a credible low inflation target they consequently would need to hold back their own wage demands.

Another example is the drive to deal with the gender wage gap. Raising the wages of women implies that unions organizing a majority of women may find support from other unions for a wage premium. This was the case in the recent round of wage negotiations in Sweden and, after some lengthy discussions among the unions in the blue collar confederation (LO), there finally was an agreement that a large union organizing a majority of women[4] should be given an extra wage increase at the expense of other unions.

[4] This was the union organizing workers in local government, Svenska kommunalarbetareförbundet. For a long time the industrial workers's union in Sweden, Svenska metallarbetareförbundet, resisted the demands since it

Many other wage redistributions are motivated in terms of compensated wage differentials. Some unions may reveal poor working conditions for their members and require compensation for exposure to e.g. higher risks of crime, pollution, cigarette smoke, crowding etc. The disciplinary effect of inflation target requires solidarity from other unions that in turn may have to restrain their own wage demands.

Other workers may be exposed to a demand from foreign employers. Such foreign demand tends to raise also their domestic wages. If their competence is considered crucial to the home country, other unions may find these wage increases agreeable and to be in the general interest, since they may prevent emigration of workers. To prevent a wage inflation that is not in compliance with the inflation target, the other unions may hold back their wage demands.

The only assumption that is necessary for our macroeconomic model with union wage setting to capture *long-run* rather than short-run relations is that such demands for wage redistribution across members of different trade unions will not go away in the long run.[5] Due to technological improvements work conditions change over time, implying that workers' demand for changing premiums will persist over time. Groups of workers that are considered underpaid will be identified also in the future and demand for redistribution will continue. Preferences for more or for less equality and the norms for a "fair" wage structure will also change in the long run leading up to demands for wage redistribution.

Several results come out of our model based on wage rigidity, inflation targeting and union wage setting. First, we show that a *sustained* need for wage redistribution across unions (worker categories) yields a negatively sloped LRPC at sufficiently low inflation rates, i.e. also with sustained redistribution the unemployment increase will come to a halt at some high level. It may be the case, however, that also a fairly low inflation level may be enough to take care of redistributions across unions without causing unemployment to rise. Inflation targets under, say, two percent are not likely to be enough, though, to prevent unemployment increases.

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limited their own wage increases. Finally, after long internal discussions they finally agreed to support the extra wage increases of Svenska kommunalarbetareförbundet.

[5] We show, however, that at zero inflation, the economy may get trapped also if redistribution demands disappear.

Secondly, we may analyze the effects of a limited period of wage redistributions after which no such redistributions are demanded by unions. We show that with a *zero* inflation target and strict wage rigidity the economy will be in a high unemployment trap, i.e. also without any demands for redistribution. With no price increases and downward rigid real or nominal wages there is no room for relative wage adjustments. At positive but low inflation targets, the economy is not trapped but the lower is inflation the larger is the necessary number of contract periods for the economy to return to NAIRU. The higher is the inflation target, the faster is the return to low unemployment. The model illustrates inflation as grease of wage formation.

Thirdly, we show that wage redistribution under downward *real* wage rigidity causes unemployment to rise at low enough levels of inflation but not at high. The unemployment increase will cease at a high NAIRU at any inflation target. While the economy returns to the NAIRU level under DNWR and any positive inflation, this is not the case under DRWR. Under real wage rigidity, the economy gets trapped at this high level also if the demands for wage redistribution vanish. With less than full DRWR, the higher is the degree of DRWR the longer time it takes for the economy to return to low unemployment levels after a period of wage redistribution.

The basic mechanism of the model can be described with a simplified example based on nominal wage rigidity as follows. Consider a wage bargaining economy with two trade unions, A and B, of identical size and a monetary regime based on targeting inflation at a zero rate. If union A, for instance one dominated by female workers, demands an extra wage increase to contribute to closing the gender wage gap, union B would need to lower its nominal wage correspondingly to assure that the overall wage increases are compatible with zero inflation. However, under an efficiency wage constraint, a nominal wage decrease of union B would distort output by lowering workers' effort yielding an undesired social outcome. To avoid this, union B will not accept a nominal wage drop and if they then agree to wage redistribution, the average wage costs to the firms will increase. To avoid higher wage costs to raise the price level, the Central Bank lowers the money supply, thus lowering aggregate demand and causing unemployment to rise. On the other hand, if inflation is high enough, wage redistribution occurs without a necessary drop in nominal wages yielding constant money supply and unemployment. In this manner, we derive a long run Phillips

curve that is vertical at high inflation but negatively sloped at low inflation. Thus, a positive inflation rate works to grease the wheels of the economy.

The Model.

Consumption

The point of departure is a New Keynesian macroeconomic model[6] into which we build in inflation targeting and the appropriate wage rigidities. We assume two goods, indexed 1 and 2. Household *i* (*i*=1…*n*) maximizes utility that depends positively on aggregate consumption C_i and real money balances M_i / P:

$$U_i = \left[\frac{C_i}{g}\right]^g \left[\frac{M_i/P}{1-g}\right]^{1-g} . \qquad (1)$$

Consumption is a function of the level of consumption of each of the two goods, $C_i = (C_{i1}^{\theta-1} + C_{i2}^{\theta-1})^{\frac{\theta}{\theta-1}}$, entering the utility function in a symmetric way. θ (>1) is the elasticity of substitution between the two goods. The constant *g* is introduced in (1) to simplify the exposition. M_i represents the nominal money holdings of the household and $P = (\frac{P_1^{1-\theta} + P_2^{1-\theta}}{2})^{\frac{1}{1-\theta}}$ is the aggregate price level corresponding to C_i.[7]

The *n* identical households own their labor and firms and maximize utility subject to their budget constraint. Labor supply of both types equals 1. Total factor income are profits $P_1Q_1 - w_1L_1$ and $P_2Q_2 - w_2L_2$, wage income w_1L_1 and w_2L_2 where *w* is the wage and *L* labor demand, plus income when unemployed $B(1-L_1+1-L_2)$ where *B* are unemployment benefits. Adding yields total factor income as $P_1Q_1 + P_2Q_2 + B(2-L_1-L_2)$ but since benefits are financed by lump-sum taxes of the same amount as total benefits, we get factor income as $P_1Q_1 + P_2Q_2$.

[6] Cf. for instance Blanchard and Fischer (1989) ch. 8.

[7] In general, introducing real money balances directly in the utility function is gross simplification and a full treatment would require a considerably more complex dynamic model. However, it is a very useful and innocent simplification that also underlines the importance of monetary policy for the demand.

For each of the *n* households, here represented by household *i*, the budget constraint, equal to income I_i, reads as:

$$P_1 C_{i1} + P_2 C_{i2} + M_i = I_i \equiv \frac{1}{n}\left[P_1 Q_1 + P_2 Q_2 + M\right]. \qquad (2)$$

Nominal consumption expenditures and demand for nominal money balances should equal income from market activities, and non-activities plus the household's initial money holdings, *M/n*. The solution to the utility maximization problem obtains by maximizing (1) subject to (2) and using the aggregation functions of consumption and price. The solution reads:

$$C_{i1} = \left[\frac{P_1}{P}\right]^{-\theta} C_i \qquad (3a)$$

$$C_{i2} = \left[\frac{P_2}{P}\right]^{-\theta} C_i \qquad (3b)$$

$$M_i = (1-g) I_i \qquad (4)$$

$$C_i = g\frac{I_i}{P} \qquad (5)$$

Demand for the two goods and for real money is linear in income and is a function of the relative price with the elasticity -θ. Using (3a, b), (4) and (5) we can define total demand for the two goods facing firms as real consumption demands, C_1^D and C_2^D, over the *n* households:

$$C_1^D = \frac{g}{1-g}\left[\frac{P_1}{P}\right]^{-\theta}\frac{M}{P} \qquad (6a)$$

and

$$C_2^D = \frac{g}{1-g}\left[\frac{P_2}{P}\right]^{-\theta}\frac{M}{P} \qquad (6b)$$

The money supply, *M*, which is the decision variable of the Central Bank, is seen to directly affect goods demand.

Production

Output, *Q*, is assumed to be produced using labor in efficiency units as the sole input:

$$Q_1 = e_1 L_1^{\gamma} \qquad (7a)$$

$$Q_2 = e_2 L_2^{\gamma} \qquad (7b)$$

where we note that labor of type 1 (type 2) is used only in production of good 1 (good 2) and that $0 < \gamma < 1$. The term *e* is effort and will be determined below. Workers are organized in

unions and there is one union connected with each firm. Firm 1 maximizes profits $\Pi_1 = \frac{P_1}{P} Q_1 - \frac{w_1}{P} L_1$ by setting the price P_1. In maximizing profits, the firm considers that output is determined by demand (6a), the production function (7a) and wage and the price level are taken as given. Effort equals unity (see below). The solution is:

$$P_1 = P(\frac{\theta}{\gamma(\theta-1)} \frac{w_1}{P})^{\frac{1}{1-\theta+\theta/\gamma}} (\frac{gM}{(1-g)P})^{\frac{1-\gamma}{\gamma(1-\theta+\theta/\gamma)}}. \qquad (8a)$$

Similarly for Firm 2 that considers (6a) and (7a) we get

$$P_2 = P(\frac{\theta}{\gamma(\theta-1)} \frac{w_2}{P})^{\frac{1}{1-\theta+\theta/\gamma}} (\frac{gM}{(1-g)P})^{\frac{1-\gamma}{\gamma(1-\theta+\theta/\gamma)}}. \qquad (8b)$$

Averaging (8a) and (8b) we get the aggregate price level $P = (\frac{P_1^{1-\theta} + P_2^{1-\theta}}{2})^{\frac{1}{1-\theta}}$ as

$$P = (\frac{g}{1-g})^{1-\gamma} (\frac{\theta}{\gamma(\theta-1)})^{\gamma} W^{\gamma} M^{1-\gamma} \qquad (9)$$

where *W* is the index of aggregate wages $W = (\frac{w_1^{1-\theta/(\gamma+\theta(1-\gamma))} + w_2^{1-\theta/(\gamma+\theta(1-\gamma))}}{2})^{\frac{1}{1-\theta/(\gamma+\theta(1-\gamma))}}$.

Facing a wage increase, we see from (9) that the Central Bank may lower money supply to keep the price level constant. The two firms also maximize profits by determining labour demand, which, for firm 1, yields:

$$L_1^d = (\frac{g}{1-g} \frac{M}{P})^{\frac{1}{\gamma+\theta(1-\gamma)}} (\frac{\theta}{\gamma(\theta-1)} \frac{w_1}{P})^{\frac{-\theta}{\gamma+\theta(1-\gamma)}} \qquad (10a)$$

and for Firm 2

$$L_2^d = (\frac{g}{1-g} \frac{M}{P})^{\frac{1}{\gamma+\theta(1-\gamma)}} (\frac{\theta}{\gamma(\theta-1)} \frac{w_2}{P})^{\frac{-\theta}{\gamma+\theta(1-\gamma)}}. \qquad (10b)$$

Productivity, wages, and rigidities

At this stage the specific assumptions and special features of the model show up. Inspired by the efficiency wage theory we assume that effort of a worker equals unity if the workers' wage (say type 1), w_1, is at least as high as last years' wage, w_{1-1}. If less than last year's wage, effort is zero. Formally, we have strict downward *nominal* wage rigidity, DNWR, as:

$$e_1 = 1 \qquad \text{if} \qquad w_1 \geq w_{1-1} \qquad (11a)$$

$$e_1 = 0 \qquad \text{if} \qquad w_1 < w_{1-1}. \qquad (11b)$$

Since a zero effort solution is assumed unacceptable to the unions, they will never set the wage below last year's wage if there is DNWR. The same assumptions and similar equations as (11a) and (11b) apply to workers of type 2.

In some other cases we may assume downward *real* wage rigidity, DRWR, specified as

$$e_1 = 1 \qquad \text{if} \qquad w_1 / P \geq w_{1-1} / P_{-1} \qquad (11c)$$

$$e_1 = 0 \qquad \text{if} \qquad w_1 / P < w_{1-1} / P_{-1}. \qquad (11d)$$

for worker type1, where P_{-1} is last period's price level. The corresponding equations apply to workers of type 2.

The wage expected by the unions' members and leadership is determined as last year's wage adjusted for expected inflation which equals targeted inflation , $\bar{\pi}$, and an extra wage adjustment, γ_j, to compensate for some (positive or negative) exogenous shifts in preferences, work conditions etc. as discussed above. We can write the expected wage for the two types of workers as

$$w_1^e = w_{1-1}(1+\bar{\pi})V_1 \qquad (12a)$$

and

$$w_2^e = w_{2-1}(1+\bar{\pi})V_2 \qquad (12b)$$

Thus the *relative* expected price is

$$w^e = w_1^e / w_2^e = (w_{1-1} / w_{2-1})V \qquad (13)$$

where $V = V_1 / V_2$.

Solidarity across the two unions implies that they set the wages in consideration of an expected wage redistribution as suggested in (13). Unions consider their members' utility plus a term capturing the desired change in relative wages across the two unions. This desired redistribution of wages may be formulated as

$$\frac{\Psi}{2}\left[\frac{w_{1-1}}{w_{2-1}}V - \frac{w_1}{w_2}\right]^2 \qquad (13b)$$

(13b) implies that as long as there is a deviation between the actual wages w_1 / w_2 and the desired wages $\frac{w_{1-1}}{w_{2-1}}V$, there will be a utility loss imposed on the unions. The term is convex in w_1. Think of this redistribution as representing the type of social goals discussed in the introduction. We can then think of the unions as having a joint maximand that reads:

$$\underset{\arg\max w_1, w_2}{\Omega} = (1-u_1(\frac{w_1}{P}))\frac{w_1}{P} + u_1(\frac{w_1}{P})B + (1-u_2(\frac{w_2}{P}))\frac{w_2}{P} + u_2(\frac{w_2}{P})B - \frac{\Psi}{2}\left[\frac{w_{1-1}}{w_{2-1}}V - \frac{w_1}{w_2}\right]^2 \quad (14)$$

The first two terms in (14) are the standard expected wage of members of union 1, the third and fourth term the standard expected wage of members of union 2. The fifth term is the added redistribution term, which due to solidarity between the two unions, is desired by both unions.

The maximization process obtained by setting $\delta\Omega/\delta w_1 = 0$ and $\delta\Omega/\delta w_2 = 0$ leads up to the following first order conditions: $(\frac{\delta u_1}{\delta w_1} / P\ )(B - \frac{w_1}{P}) + (1-u_1)/P\ = -\Psi\left[\frac{w_{1-1}}{w_{2-1}}V - \frac{w_1}{w_2}\right]\frac{1}{w_2}$

and $(\frac{\delta u_2}{\delta w_2} / P\ )(B - \frac{w_2}{P}) + (1-u_2)/P\ = \Psi\left[\frac{w_{1-1}}{w_{2-1}}V - \frac{w_1}{w_2}\right]\frac{w_1}{(w_2)^2}$. To solve for the derivative $\frac{\delta u_1}{\delta w_1}$ we note that the unemployment rate of union 1 members is

$u_1 = 1 - L_1 = 1 - (\frac{g}{1-g}\frac{M}{P})^{\frac{1}{\gamma+\theta(1-\gamma)}}(\frac{\theta}{\gamma(\theta-1)}\frac{w_1}{P})^{\frac{-\theta}{\gamma+\theta(1-\gamma)}}$ from which we obtain

$\frac{\delta u_1}{\delta w_1} = \frac{\theta}{\gamma+\theta(1-\gamma)}\frac{L_1}{w_1}$ and similarly we obtain for union 2 $\frac{\delta u_2}{\delta w_2} = \frac{\theta}{\gamma+\theta(1-\gamma)}\frac{L_2}{w_2}$. When used in the corresponding first order conditions we get:

$$(\frac{\theta}{\gamma+\theta(1-\gamma)}\frac{L_1}{w_1 P})(B - \frac{w_1}{P}) + (1-u_1)/P = -\Psi\left[\frac{w_{1-1}}{w_{2-1}}V - \frac{w_1}{w_2}\right]\frac{1}{w_2} \qquad (15a)$$

and

$$(\frac{\theta}{\gamma+\theta(1-\gamma)}\frac{L_2}{w_2 P})(B - \frac{w_2}{P}) + (1-u_2)/P = \Psi\left[\frac{w_{1-1}}{w_{2-1}}V - \frac{w_1}{w_2}\right]\frac{w_1}{(w_2)^2} \qquad (15b)$$

Monetary Policy: Inflation targeting

The Central Bank adjusts the money supply to obtain a price level at time *t* that equals last period's price level P_{-1} corrected for the inflation target $\bar{\pi}$:

$$P = P_{-1}(1+\bar{\pi}). \qquad (16)$$

The averages of (8a) and (8b) should then equal the price level as in (16). Using (16) in the average price level (9) and solving for *M* we obtain:

$$M = \left[\left[\frac{g}{1-g}\right]^{1-\gamma}\left[\frac{\theta}{\gamma(\theta-1)}\right]^{\gamma}\right]^{-\frac{1}{1-\gamma}} W^{\frac{-\gamma}{1-\gamma}}(P_{-1}(1+\bar{\pi}))^{\frac{1}{1-\gamma}}. \qquad (17)$$

Thus, when the Central Bank sets the money supply according to (17), the inflation target specified in (16) will be fulfilled. Firms will set their prices according to (8a) and (8b) still complying with the inflation target (16).

Properties and Predictions:

a) The vertical LRPC

We shall discuss the properties and predictions by means of numerical simulations. With *no* demand for wage redistribution across the two unions, i.e. *V*=1.00, the model will of course produce a standard vertical LRPC. We assume the following parameter values: *g*=.3, θ=5, γ=.77, ψ=1.0 and *B*=.548. Assuming no demand for redistribution across unions from last period, *V*=1.0, we obtain the thick LRPC as illustrated in Figure 1.

In the no redistribution case the standard result of no relation between inflation and unemployment occurs. Unemployment is at its NAIRU level, here 2.86 percent.

Assuming now that there is demand for a period-wise redistribution of 2 percent, i.e. that *V*=1.02. This implies that in period 1 union 1 demands two percent more than union 2, in period 2, union 2 demands two percent more than union 1, in period 3 union 1 again demands two percent more than union 2 and so on. With perfect wage flexibility the LRPC will remain fixed at the NAIRU rate of 2.86 percent. However, every second contract period, union 1 (union 2) will find that unemployment among their members falls (rises) and every second

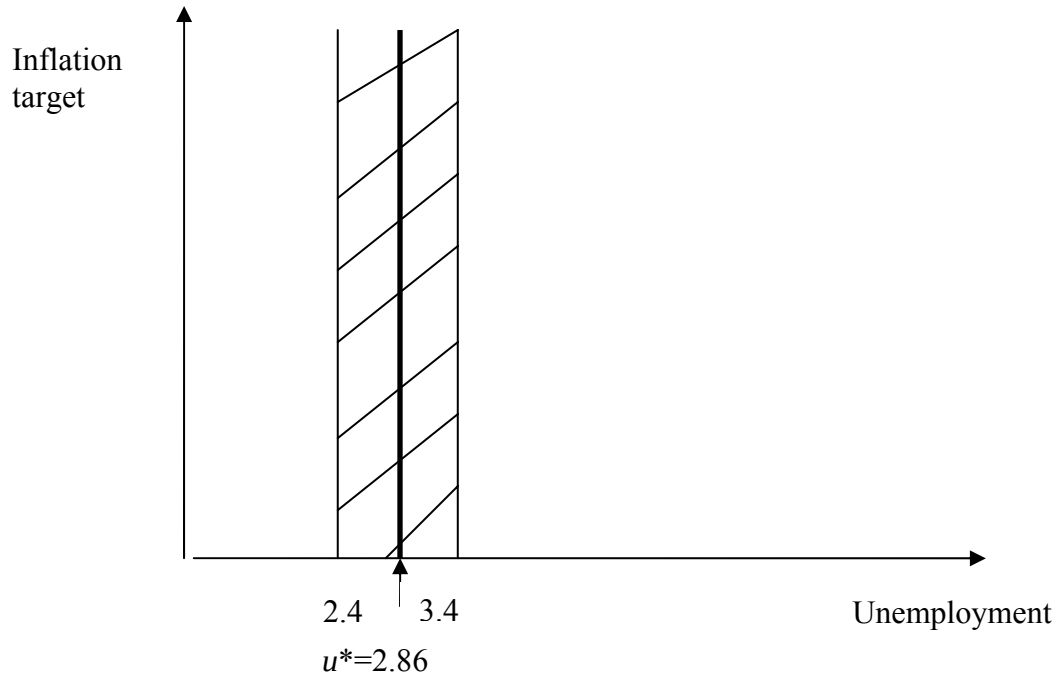

Figure 1. **The bolded line shows the long-run Phillips curve under no redistribution or under wage redistribution with wage flexibility yielding unemployment intervals for two unions.**

period unemployment rises (falls). Thus, over time unemployment among members of the two unions will vary within the shaded area in Figure 1. Unemployment in the two unions will vary between 2.4 and 3.4 percent while the average unemployment rate remains at NAIRU, 2.86 percent.

b) Introducing wage rigidity

In the sections below, we analyze the effects of wage rigidity on the LRPC. We first study the effects of the less restrictive case of rigidity, downward nominal wage rigidity, i.e. when a union refuses to set the nominal wage below last years' wage. This case is represented by applying (11a) and (11b). We then turn to the more restrictive case when the union refuses to set the wage below last years' wage corrected for inflation, as represented in (11c) and (11d). Of course, at price stability, $\overline{\pi} = 0$, the two are identical phenomena.

Nominal wage rigidity

We shall first show how the LRPC is affected by the introduction of DNWR at different levels of inflation targeting. Assume that in each contract period five percent wage redistribution is required by a union (union) as before representing half of the union membership. We do not choose this very high level of redistribution because of realism but rather to show the workings of the model. The resulting long-run Phillips curve is shown in Figure 3.

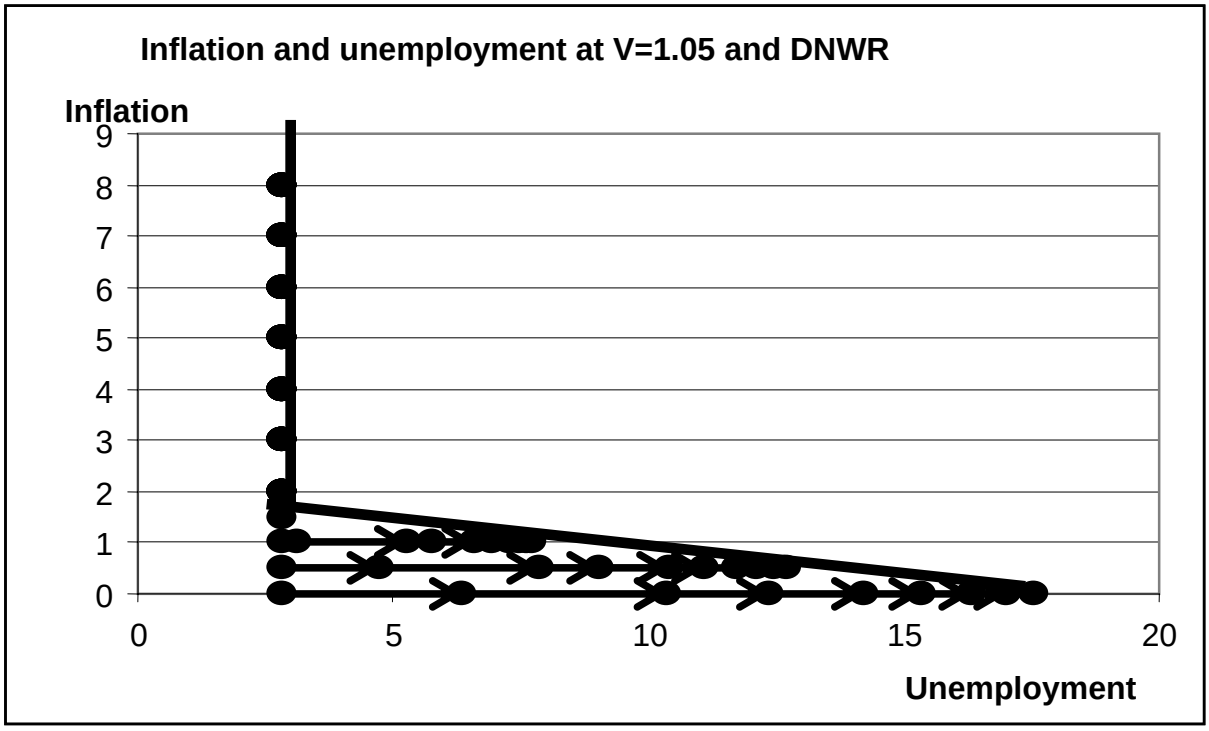

Figure 3. The long-run Phillips curve under downward nominal wage rigidity and V=1.05.

Of course, at high enough inflation a wage cut is not required for real wage adjustment and DNWR does not matter. In this case, 1.5 percent inflation is enough "grease" for real wage adjustment to occur and unemployment remains at the NAIRU level. At lower inflation rates, however, DNWR implies a restriction on real wage adjustment. At inflation less than around 1.5 percent, a nominal wage cut on behalf of the wage restraining union would have been necessary to avoid unemployment from increasing. However, under DNWR unemployment will increase and in the long run unemployment settle at a level higher than NAIRU. Consider, for instance, an inflation target at 1 percent. Since V=1.05, union 1 demands 5 percent more than union 2 (at unchanged unemployment). With DNWR, union 2 will not

lower their real wages fully to make up for the wage hike of union 1 and the result is an increase in the overall unemployment rate. Still, a one percent inflation rate implies some, but not enough, "grease" to restrict unemployment increases.[8] For each contract period, unemployment increases as follows: 2.86 %, 3.15 %, 5.29 %, 5.77 %, 6.60 %, 6.92 %, 7.28 %, 7.64 % and 7.76 %. It thus approaches around 8 percent where it will remain as long as the wage redistribution demand remains.

Why does the unemployment increase taper off though demand for wage redistribution remains? When in the second contract period, union 2 demands five percent more than union 1, union 1 cannot adjust real wages fully and unemployment will go up further. However, when unemployment increases over time for each contract period, the disutility of increasing unemployment goes up, and less and less wage redistribution can be accepted. Thus even if V=1.05 remains in the long run, ultimately wage redistribution will come to a halt since the costs in terms of extra unemployment becomes too large to pursue the redistribution. After about nine contract periods, unemployment has settled at its long run rate, here close to 8 percent and there is no further redistribution.

Price stability, i.e. zero percent inflation, is an ultimate case to study. Here, under DNWR, no real wage adjustment whatsoever on the part of the wage restriction union can take place. In this case, at the very high wage redistribution rate, we see that unemployment ends up at a very high level: 17.5 percent. Compared to long-run unemployment at 1 percent we see that it makes a large difference whether inflation is targeted at 1 or 0 percent.

Reducing redistribution demand under DNWR.

The unemployment trap at price stability

At the long-run equilibrium, V has been assumed to remain at 1.05. The high unemployment rate makes unions uninterested in further redistributions since that would raise unemployment even more. We could ask, though, what would happen if unions should become satisfied with the relative wages, i.e. becomes V=1.0 when we are at the long-run Phillips curve and at zero inflation.

[8] Note that we start out at equal wage levels in the two unions. Therefore, the first "step", i.e. unemployment increase, is not as large as it had been had we assumed large wage differences also in the initial period. A one percent inflation restricts the initial step.

Unions will now find that their *relative* wages are the optimal ones. However, both would like to have lower real wages so that unemployment would come down to the preferred level, i.e. NAIRU. A choice of wages under full wage flexibility implies real wages that yield the NAIRU of 2.86 percent. However, at the high unemployment, and restricted by full DNWR, the unions cannot adjust wages downward and we find that the high unemployment point is a trap from which the unions cannot escape. With no "grease" in the machinery we are stuck in a high unemployment trap.

Assume instead some "grease", say one percent inflation. With a positive inflation rate there is some scope for reducing real wages since if nominal wages are constant, real wages will fall. At low inflation, however, this adjustment takes time and we may experience unacceptably high unemployment rates for many contract periods.

A level of V=1.05 appears to be a high demand for wage redistribution. Figures 4 and 5 show the LRPC as V=1.02 and 1.04, respectively.

Figure 4. The long-run Phillips curve under downward nominal wage rigidity and V=1.02.

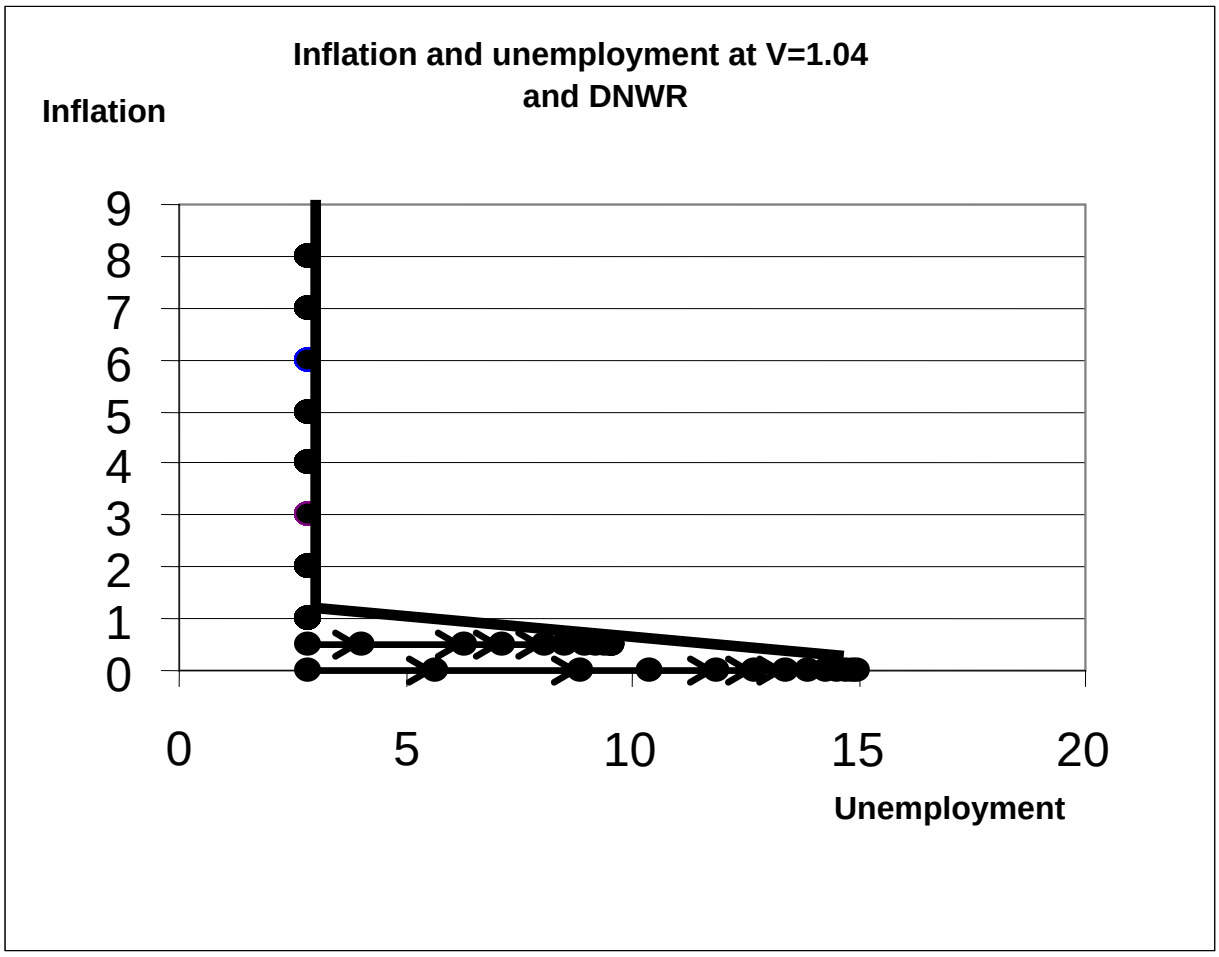

Figure 5. The long-run Phillips curve under downward nominal wage rigidity and V=1.04.

We can note that a fairly low inflation target seems to do the job of greasing the economy. Note that even when we assume as high a wage redistribution rate as 5 percent, i.e. *V*=1.05 (Figure 3), a two percent inflation target prevents unemployment from rising. At a 2 percent wage redistribution demand, illustrated in Figure 4, half a percent of inflation is enough to grease the economy. Doubling the wage redistribution demand to V=1.04, a little more than one percent inflation is enough to keep unemployment at NAIRU.

These simulations could perhaps imply that DNWR really is not a major problem as long as Central Banks target the inflation rates at around 2 percent. However, economies are also exposed to real wage rigidity to which we now turn.

Real wage rigidity

Introducing real wage rigidity implies that a union that under wage flexibility had reduced the real wage in solidarity with the wage increasing union now will refuse to do so. Instead it will raise the nominal wage at least as much as the expected (targeted) inflation rate so as to avoid real wages from falling.

With a positive redistribution demand, i.e. $V>1.00$, and with the wage restraining union restricting its nominal wage hikes to the targeted inflation rate to keep the real wage constant, one might have expected that unemployment would increase at *any* inflation target. This is not the case, however. At high enough inflation, unemployment remains at the NAIRU level. At zero inflation unemployment becomes identical to the one obtained under DNWR. As noted, at zero inflation, DNWR and DRWR are identical concepts yielding identical solutions. In Figure 6, we show the derived LRPC as $V=1.05$ and the zero inflation solution is seen to be identical to the zero inflation solution in Figure 3.

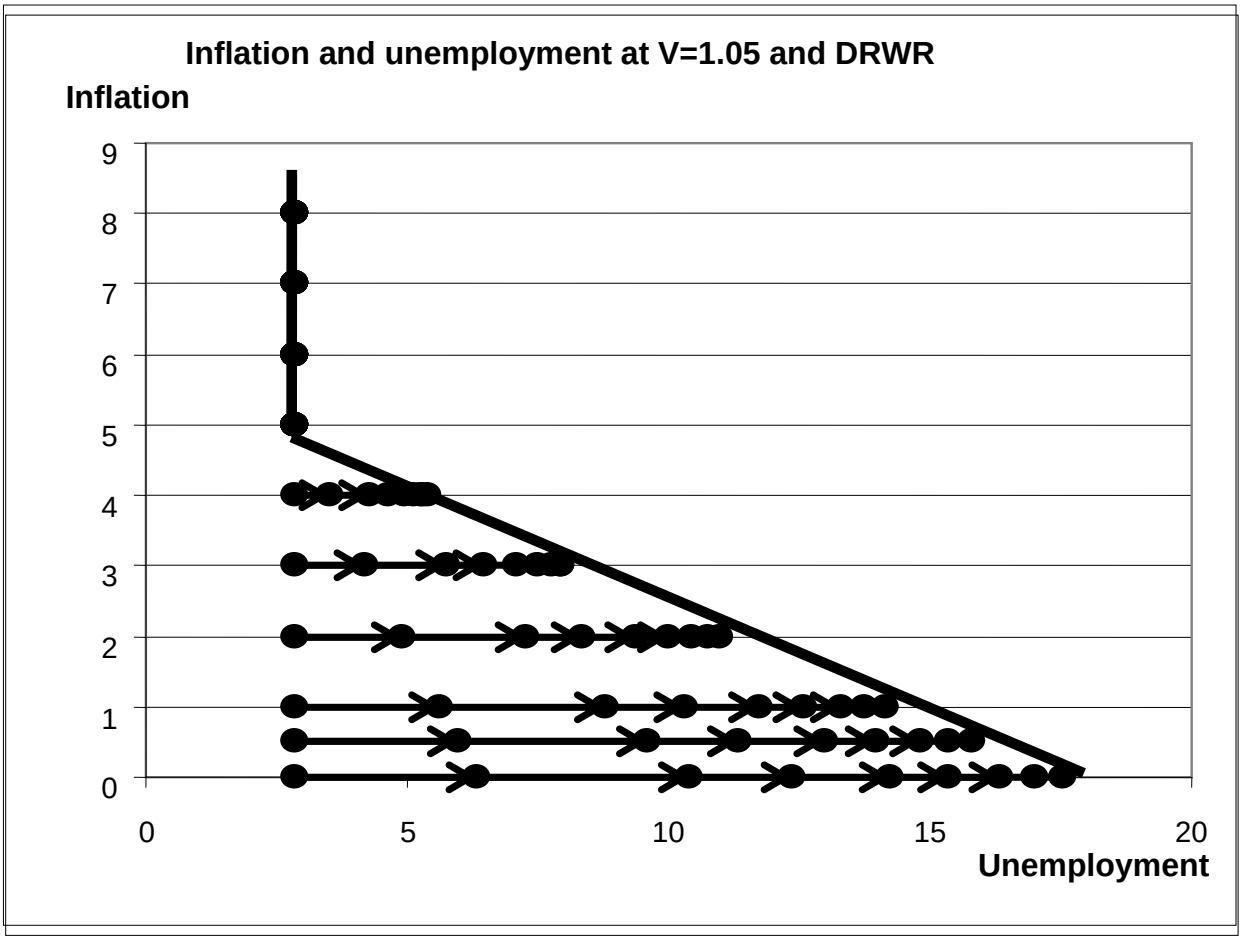

Figure 6. The long-run Phillips curve under downward real wage rigidity and V=1.05.

Why is it that at higher inflation the LRPC is negatively sloped and becomes vertical at around 5 percent inflation? Assume a redistribution of wages in favour of union 1. DRWR (like DNWR) expresses how small wage increase union 2 is willing to accept to allow union 1 a higher wage increase. The DRWR regime implies that union 2 is not very cooperative as union 2 always raises its wage as much as the inflation rate. At low inflation union 2 raises its wage by the low inflation rate, giving scope for union 1 to raise its wage by *more* than the inflation rate so as to lowering the loss term in (13b). Since union 1 raises the wage above the inflation rate, real wage costs rise and unemployment goes up. At high inflation, on the other hand, union 2 raises its wage by the high inflation rate thus giving no scope for union 1 to raise its wage above the inflation rate. Thus, like union 2, union 1 will also raise its wage by the inflation rate and real wage costs are unchanged and unemployment remains at NAIRU. Consequently we obtain a LRPC that is vertical at high inflation rates, where both unions raise wages by the inflation rate, and negatively sloped at low inflation rates, where union 1 raises its wage above the inflation rate.

The crucial equations are (15a) and (15b). On the left hand side we find the standard effects of raising the wage, i.e. the effects on real wages and employment. On the right hand side we find the effects on the wage redistribution. Based on (15a), we show in Appendix 1 that union 1 will increase its wage by more than the inflation rate at a low inflation rate. We also show that the rate of increase of union 1's wage falls as inflation gets higher and that there exists a positive inflation rate at which union 1 will select a wage increase identical to the inflation rate. This latter inflation rate is the one at which the LRPC changes from being negatively sloped to being vertical. In Figure 6, this occurs at approximately 5 percent inflation.

At a low inflation rate, union 1 finds it rational to accept a higher unemployment rate since their real wage increase also implies an increase in their wage relative union 2. Hence, the difference between actual relative wages and desired real wages, $\left[\frac{w_{1-1}}{w_{2-1}}V-\frac{w_1}{w_2}\right]$, falls. Since the term $\frac{\Psi}{2}\left[\frac{w_{1-1}}{w_{2-1}}V-\frac{w_1}{w_2}\right]^2$ is convex in w_1, (see Appendix 2) higher inflation implies that union 2 selects a higher w_2, union 1 finds that at some higher inflation rate it cannot

efficiently reduce $\left[\frac{w_{1-1}}{w_{2-1}}V - \frac{w_1}{w_2}\right]$ by choosing a wage increase above the inflation rate.[9] Rationally, it opts for a wage increase identical to the inflation rate.

Comparing Figure 6 to Figure 3, we see that downward real wage rigidity has a strong impact on the LRPC. Under DNWR (Figure 3), 1.5 percent inflation is enough to keep unemployment at the NAIRU level. Under the more restrictive DRWR, somewhat more than four percent is needed to keep unemployment at NAIRU.

A V=1.05 may seem to imply a high demand for wage redistribution. Figure 8 shows the LRPC at the considerably lower level of V=1.02. The zero inflation solution is of course again identical to the one under DNWR as in Figure 4 and we see here that 2 percent inflation is enough to keep unemployment at the lowest level of 2.86 percent, i.e. at NAIRU.

A V=1.04 yields the LRPC depicted in Figure 9. Here, four percent inflation is needed to keep unemployment down at the minimum level.

Reducing redistribution demand under DRWR.
Unemployment traps at low inflation targets.
We noted above that in the case when demand for redistribution falls, i.e. when V becomes 1.00 under DNWR, the economy would be trapped at very high unemployment when inflation is zero. When inflation is positive, however, it moves back to the NAIRU level but very slowly so when inflation is low. Do these results carry over to the case of DRWR?

No! In this case, the economy is trapped at high unemployment not only at price stability, i.e. at zero inflation, as in the DNWR but *also at all other levels of inflation target*. If DRWR is a binding restriction on the wage formation, there is no way back to the NAIRU level of unemployment once we have ended up on the negative sections of the long-term Phillips curves depicted in Figures 6, 8 and 9. At real wage rigidity, no real wage adjustment can take place that would take the economy back to the NAIRU level.

[9] The convexity is of course imperative to our results, but it is hard to

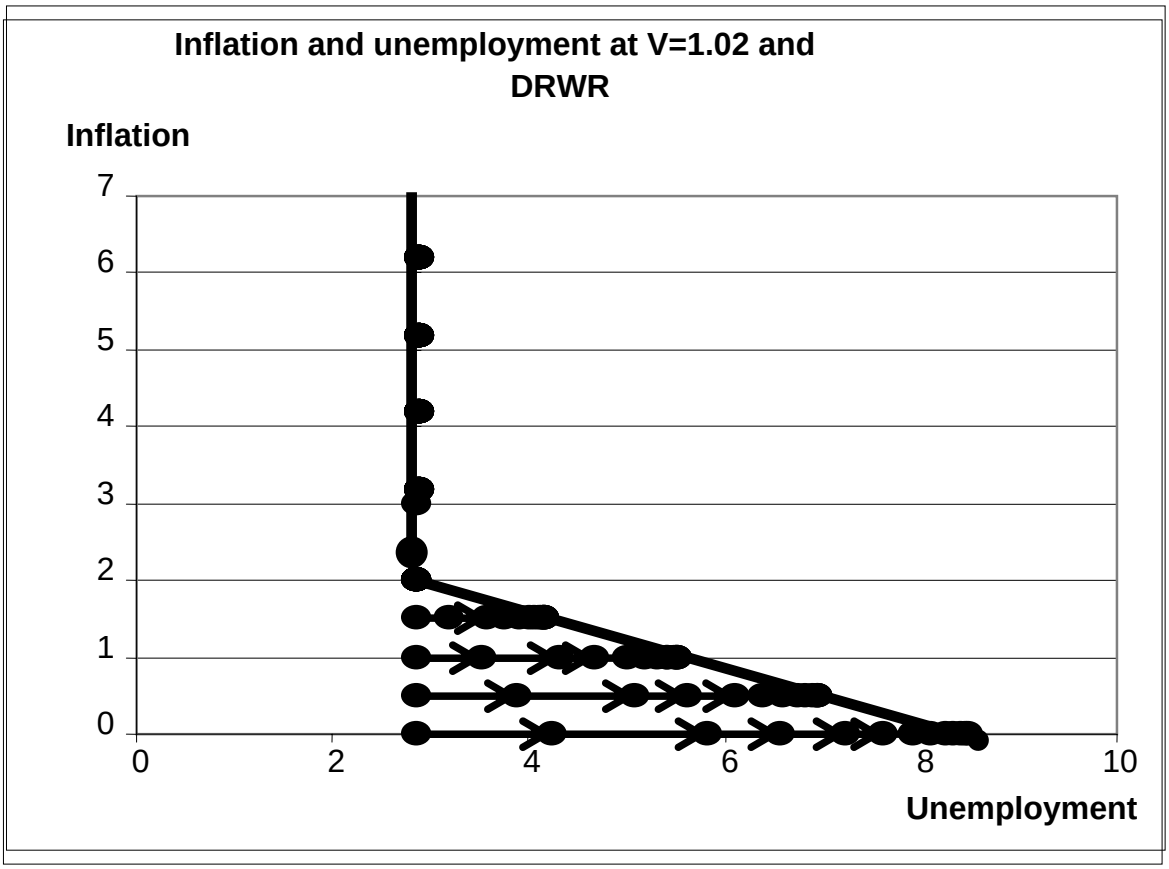

Figure 8. The long-run Phillips curve under downward real wage rigidity and V=1.02.

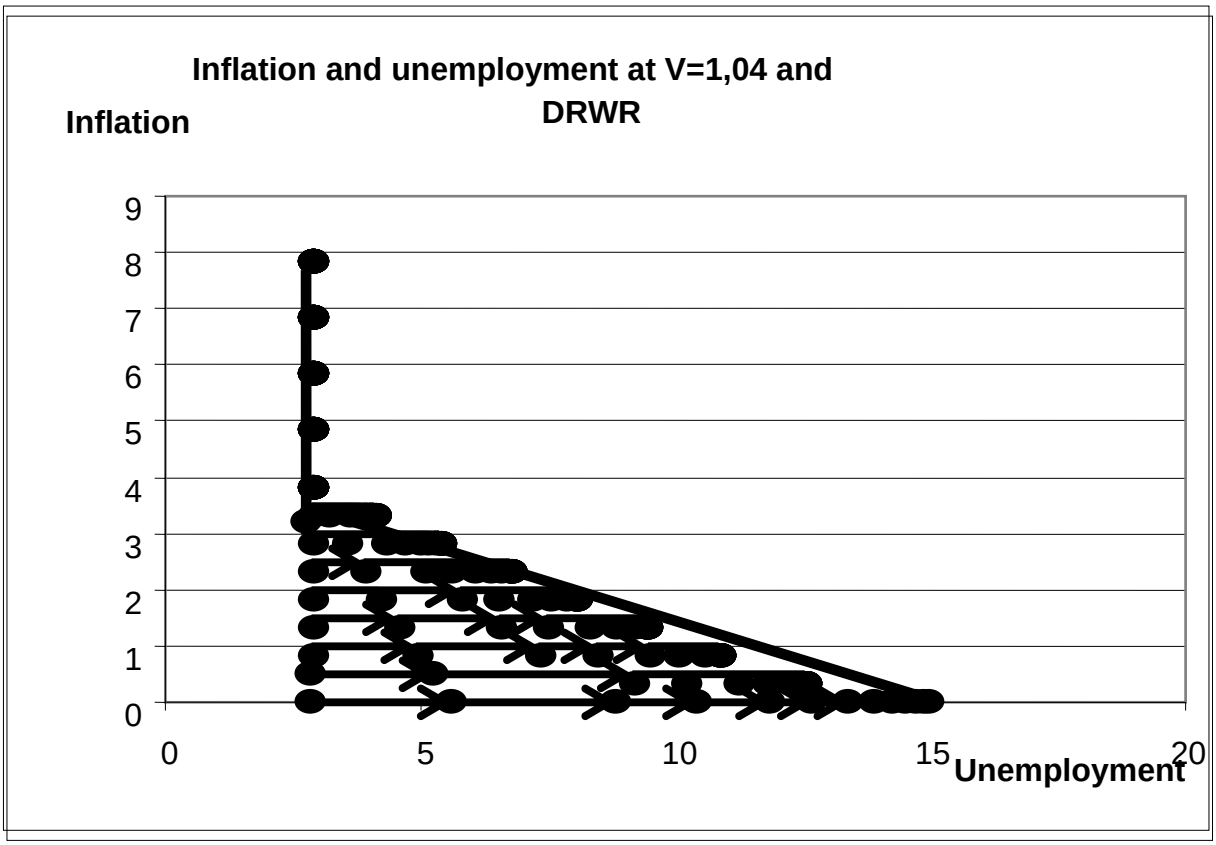

Figure 9. The long-run Phillips curve under downward real wage rigidity and V=1.04.

Empirical credibility?

So far, we are a long way from empirical credibility. Not only have we assumed redistributions like V=1.05 that seem empirically quite unrealistic but we have also assumed the whole labor force to be characterized by either nominal or real wage rigidity. Can empirical research on DNWR and DRWR be of any guidance in putting some realistic figures on our model?

The first empirical studies on nominal wage rigidity, McLaughlin (1994) and Lebow (1995), found little evidence of its existence while Akerlof et al (1996), Card and Hyslop (1996), Kahn (1997) and Altonji and Devereux (1999), Lebow et al (1999) found quite strong evidence. All these studies are based on US data during relatively high inflation, 3.4 to 7.4 percent, and though DNWR exists under high inflation, one cannot draw any inferences about the existence of DNWR under low inflation. For nominal wage rigidity to have real effects on the economy it is necessary, as amply shown in this paper that it also exists in low inflation environments. While DNWR exists in high inflation, it has been hypothesized that nominal wage rigidity will not persist in the long run under low inflation.[10] The argument that DNWR carries over from high inflation to low inflation situations is subject to the Lucas critique, i.e. the microeconomic behavior would change as inflation changes, implying that DNWR need not exist under low inflation. However, the only available evidence on DNWR in a low inflation environment is provided by Fehr and Goette (2005) who show, using low inflation Swiss data that DNWR persists also under low inflation.[11]

The most comprehensive evaluation of DNWR and DRWR has been provided by the international wage flexibility project reported by Dickens et al (2005). They find that the fraction of workers potentially affected by DNWR range from 9 % (Germany) to 66 % (Portugal) while the fraction exposed to DRWR varies from 3 % (Greece) to 52 % (Sweden).

Thus, for a country like Sweden their results suggest that around half of the work force is exposed to DRWR. We may interpret this by considering a situation in which half of membership of the two unions has flexible wages while the other half is characterized by

[10] See Gordon (1996) and Mankiw (1996).

[11] They conclude: ”Yet, the results indicate that the low inflation environment only slightly reduced the reluctance to cut nominal wages. This decrease was far too small to accommodate the greater need for nominal wage cuts as inflation approached zero. Instead of a decrease in the quantitative relevance of nominal wage rigidity, we actually observe an increase over time.” Fehr and Goette (2005) p. 781.

DRWR. Thus, the wage restraining union will lower the real wage to half between the flexible wage level and the nominal wage that implies constant real wages. Thus instead of assuming that the wage floor is determined by $\bar{\pi}$, it will be determined by $\frac{1}{2}(w^* + w_{-1}(1+\bar{\pi}))$ where w^* is the equilibrium wage under fully flexible wages and $w_{-1}(1+\bar{\pi})$ is the wage set under DRWR.[12]

We have performed simulations under the above assumptions that are likely to take us closer to a real world situation. Consider Figure 10, showing the results when half of membership is restricted by DRWR and *V*=1.05.

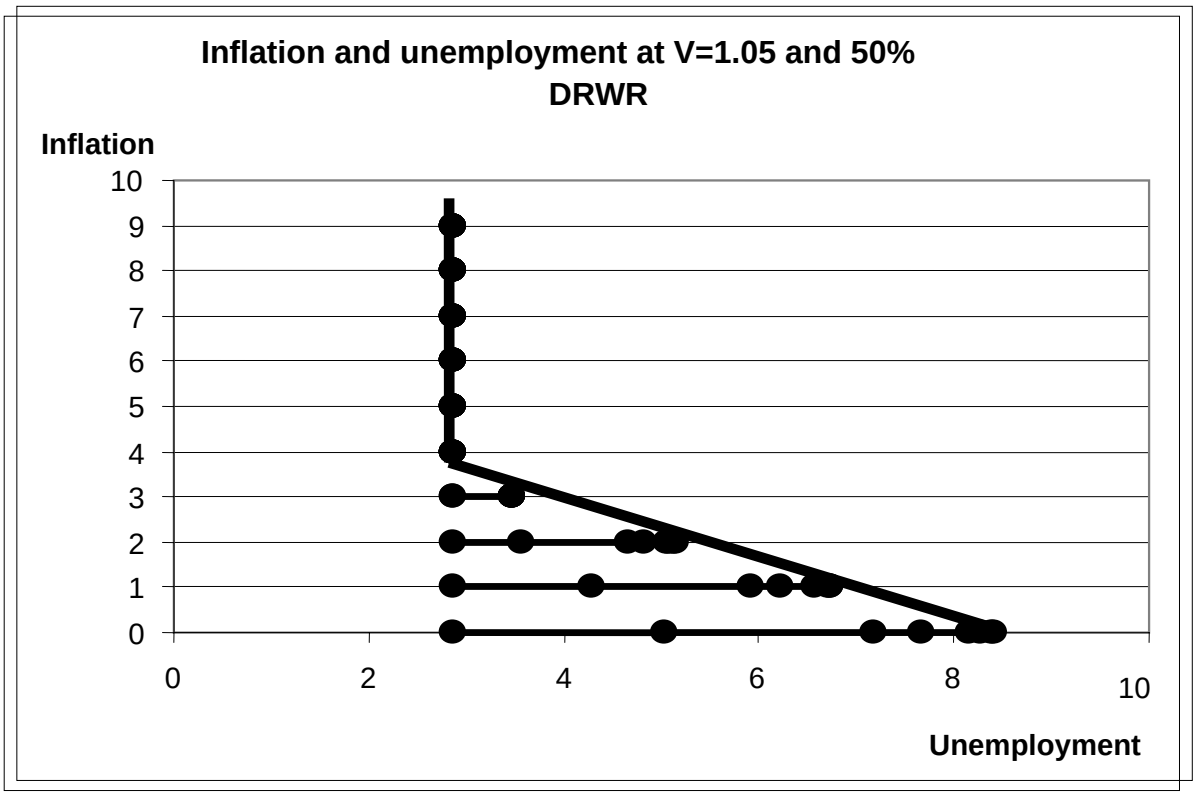

Figure 10. The long-run Phillips curve under 50 percent downward real wage rigidity and V=1.05.

V=1.05 appears, as already noted, to be a high level of demand for wage redistribution. The Swedish Riksbank has a 2 percent inflation target and the results suggest that the economy would be unable to handle such redistribution demands and at the same time keep

[12] This approach may underestimate the rigidity of real wages since we assume that those not characterized by DRWR are willing to go all the way and accept fully flexible wages. In reality they may accept only a limited real wage cut.

unemployment at the NAIRU level of 2.86 percent. Instead, unemployment would in the long run end up at a level of 5.2 percent. At a zero rate inflation target, unemployment would end up at 8.4 percent which is a combination of inflation and unemployment that the economy experienced in the late 1990.s.

Figure 11 provides the effects of a more realistic wage redistribution demand, *V*=1.02. The simulations yielding this curve suggest that the present 2 percent inflation target could handle the desired wage redistributions of *V*=1.02.

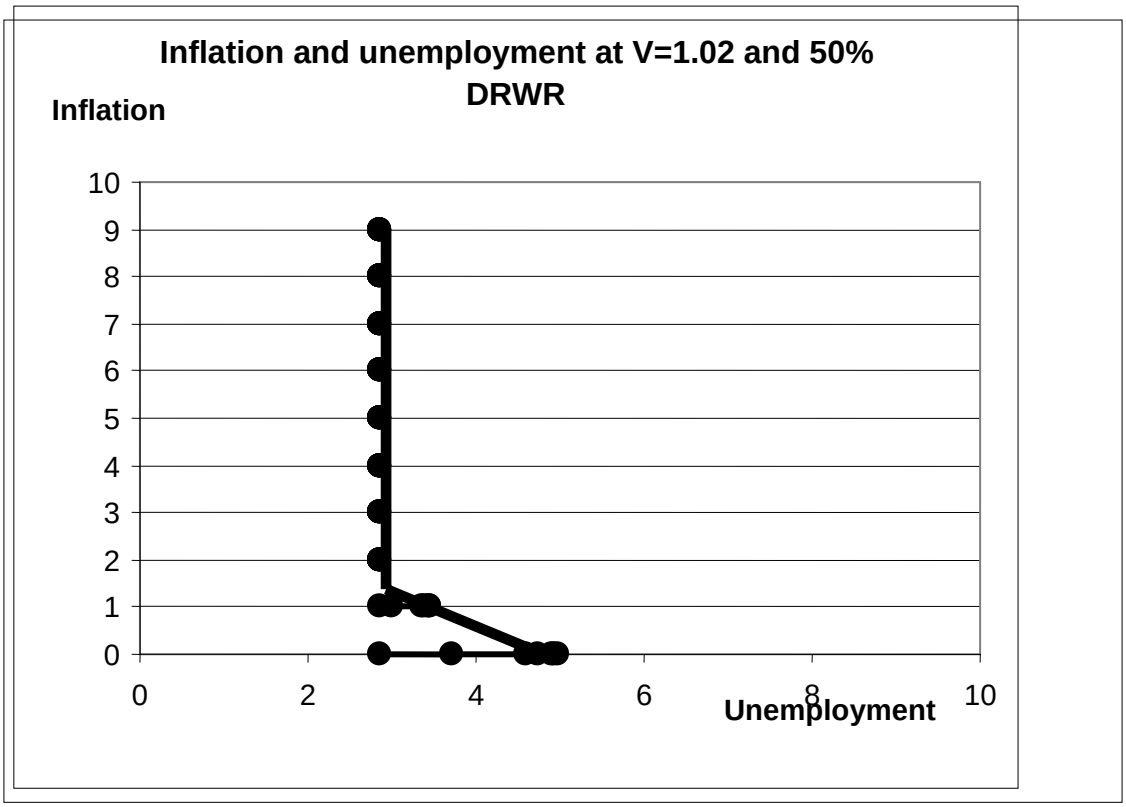

Figure 11. The long-run Phillips curve under 50 percent downward real wage rigidity and V=1.02.

Since inflation targets of two percent are not uncommon, it could be of some interest to explore the unemployment rates that different values of the redistribution factor *V* generate at this particular level of inflation target. At this target, the economy can handle wage redistribution up to 3 percent (*V*=1.03) but not more. At 3.5 percent, unemployment rises to

approximately 3.5 percent, at ends up at 5.14 percent if the redistribution parameter is as high as 1.05.

Conclusions

The only assumption needed to accept that the long-run Phillips curve has a negatively sloped segment at low inflation is that there exists, also in the long term, a need to redistribute wages across different types of workers. In a New Keynesian macroeconomic framework we show that high redistribution demands produce unemployment rates above the NAIRU level when inflation is targeted at low levels and demands for wage redistribution are large enough. Wages will be redistributed more in low unemployment periods and redistribution ceases if unemployment is high enough.

We also show that inflation targeting may trap the economy at high levels of unemployment. For instance, at zero inflation and downward nominal wage rigidity, the economy may get trapped at a high unemployment also in the case when the demand for wage redistribution disappears. The economy will return to the NAIRU level as long as there is some positive inflation rate, but the lower inflation, the longer time it takes for this to occur. At downward real wage rigidity, the situation is even worse as the economy then may get trapped at any level along the long-run Phillips curve also when wage redistribution demands are gone.

As noted, at high enough unemployment wage redistribution will not occur since that would raise unemployment to unacceptable levels. This implies that to the extent that the wage redistribution had been in the general interest there are not only social losses in terms of unemployment and production foregone, but also a loss in terms of economic efficiency. Low inflation targeting and wage rigidity is not a healthy combination for an economy.

Of course, wage rigidity is not total and we have approached the real world situation by relying on previous estimates of real wage rigidity. The simulations suggest that in an economy where half the labor force is characterized by real wage rigidity, two percent inflation, which is a common target, may be able to handle fairly large wage redistributions without unemployment increases. On the other hand, should inflation be lower the risk exists for increasing unemployment that remains also in the long run. At higher inflation there may be periods of large redistributions that take unemployment up to high levels and if followed

by periods of no or small redistributions, the return may be slow and unemployment may remain at high levels. Thus, as the paper points to problems involved in combining low inflation targeting with wage rigidity

REFERENCES

Agell, J. and Lundborg, P. (1995), Theories of Pay and Unemployment: Survey Evidence from Swedish Manufacturing Firms, *Scandinavian Journal of Economics 97*(2), 295-307.

Agell J. and Lundborg, P. (2003), Survey Evidence on Wage Rigidity and Unemployment: Sweden in the 1990s, *Scandinavian Journal of Economics 105*(1), 15-29.

Akerlof, G. A., Dickens, W. T. and Perry, G. L. (1996), The Macroeconomics of Low Inflation, *Brookings Papers on Economic Activity 1*, 1-59.

Akerlof, G. A., Dickens W. T. and Perry G. L. (2000), Near-Rational Wage and Price Setting and the Long Run Phillips Curve, *Brookings Papers on Economic Activity 1*, 1-44.

Altonji, J. G. and P. J. Devereux (1999), The Extent and Consequences of Downward Nominal Wage Rigidity, *NBER Working Paper* # 7236.

Bewley, T. E. (1999), *Why Wages Don´t Fall During a Recession*, Harvard University Press, Cambridge, MA.

Blanchard, O. J. and S. Fischer (1989), *Lectures on Macroeconomics*, the MIT Press, Cambridge, MA; London, England

Campbell, C. and K. Kamlani (1997), The Reasons for Wage Rigidity: Evidence from a Survey of Firms, *Quarterly Journal of Economics* 112, 759-789.

Card, D. and D. Hyslop (1996), Does Inflation `Grease the Wheels` of the Labor Market? NBER Working Paper # 5538.

Dickens W. T. et al (2005), The Interaction of Labor Markets and Inflation: Analysis of Micro Data from the International Wage flexibility Project, *Journal of Economic Perspectives*.

Fehr, E. and L. Goette (2005), Robustness and Real consequences of Nominal Wage Rigidity, *Journal of Monetary Economics* 52, 779-804.

Friedman, M. (1968), The Role of Monetary Policy, *American Economic Review*, March, 58, 1-17.

Gordon, R. J. (1996), *Comment and Discussion: Akerlof et al: the Macroeconomics of Low Inflation*, Brookings papers on Economic Activity, pp. 66-78.

Holden, S. (2004), The Costs of Price Stability – Downward Nominal Wage Rigidity in Europe, *Economica 71*, 282, 183-208.

Kahn, S. (1997), Evidence of Nominal Wage Stickiness from Microdata, *American Economic Review* 87, 993-1008.

Keynes, J. M. (1936), *The General Theory of Employment, Interest, and Money*, New York

Lebow, D. D. Stockton´, and W. Washer (1995), Inflation, Nominal Wage rigidity, and the Efficiency of Labor Markets, *Board of Governors of the Federal Reserve System*, Finance and Economics Discussion Series.

Lebow, D. R. Saks, and B. A. Wilson (1999), Downward Nominal Wage Rigidity: Evidence from the Employment Cost Index, *Board of Governors of the Federal Reserve System*, Finance and Economics Discussion Series.

Lundborg, P. and H. Sacklén, (2003), Low-Inflation Targeting and Unemployment Persistence, *Scandinavian Journal of Economics*, 108(3) 397-418.

Mankiw N. G. (1996), *Comment and Discussion: Akerlof et al: the Macroeconomics of Low Inflation*, Brookings papers on Economic Activity, pp. 66-78.

McLaughlin, K. (1994), Rigid Wages? *Journal of Monetary Economics* 34, 383-414.

Phelps, E. S. (1970), *Micro-economic Foundations of Employment and Inflation Theory*, New York.

Tobin, J. (1972), Inflation and Unemployment, *American Economic Review 62*(1), 1-18.